بسم الله الرحمن الرحيم

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Replacement of Some Plant Protein Sources by Sunflower Cake with or Without Enzyme in Broiler Rations

استبدال بعض مصادر البروتين النباتية كسب زهره الشمس مع أو بدون الإنزيم في علائق الدجاج اللاحم

By

Nazar Ali Mohammed Ali Siddig

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Supervisor

Prof. Mukhtar Ahmed Mukhar

Department of Animal Production

College of Agriculture Studies

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الآية

قال تعالى:

(وَلَحْمِ طَيْرٍ مِمَّا يَشْتَهُونَ)

صدق الله العظيم

سورة الواقعة الآية (21)

Dedication

I would like to dedicate this work to:

My Father

My Mother

My brother and my sisters

and to all my friends.

Acknowledgements

First of all I would like to express my thanks to my God to give me health and help me complete this study, and to my supervisor **Prof. Mukhtar Ahmed Mukhtar** for his help and advice for helpful assistance ,patience and supervision during this work.

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Abstract

Total of two hundred and ten unsexed commercial chicks arboracers were used in this experiment to evaluate the effect of feeding different levels of sunflower meal (SFM) with and without dietary enzyme on performance of broiler chicks. Five experimental diets were formulated, each diet was divided into two, to have ten experiment diets, chicks were divided according to diets and each treatment was further subdivided into three replicates with 7chicks per each replicate . in complete randomize design First group fed on negative control diet (without SFM and enzyme), second group fed on positive diet (with enzyme), and groups (3^{rd}, 4^{th}, 5^{th} and 6^{th}) were fed on diets containing SFM at 25, 50, 75 and 100%.

Other experimental chicks groups (7^{th}, 8^{th}, 9^{th} and ten) were fed on the same diets of (3^{rd}, 4^{th}, 5^{th} and 6^{th}) groups but supplemented with dietary enzyme (1g/kg commercial phytase). The experiment was lasted for six weeks. The measured parameters covered performance (body weight, feed intake, body weight gain, feed conversion ratio), carcass characteristics, non- carcass components, serum constituents, serum enzyme activities and economical attributes. Results obtained revealed that broiler chicks fed on all levels of SFM with or without enzyme significantly improved chicks performance although there is no significant difference between groups fed on different levels of SFM. The inclusion of different levels of SFM with or without enzyme did not significantly affect on non- carcass components except gizzard and commercial cuts and their meat values. Inclusion of SFM with and without enzyme in broiler diets recorded economical benefits. Results revealed that SFM can substitute vegetable protein sources without any adverse effects.

ملخص الدراسة

إستخدمت في هذه التجربة 210 كتكوت لاحم تجاري سلاله اربيريكر لدراسة التغذية على مستويات مختلفة من وجبة زهرة الشمس بإضافة أو بدون الإنزيمات الغذائية وأثرها على أداء كتاكيت اللحم.

تم تكوين خمسة أغذية تجريبية، كل واحدة قسمت لقسمين للحصول على عشرة أغذية. تم تقسيم الكتاكيت على ضوء الغذاءات وكل تجربة قسمت لثلاث مكررات يحتوي كل مكرر على سبعة كتاكيت بالنظام العشوائي الكامل.

تمت تغذية المجموعة الأولى على تغذية مراقبة سالبة بدون وجبة زهرة الشمس أو إنزيم. المجموعة الثانية تمت تغذيتها على غذاء موجب به إنزيم والمجموعات (الثالثة، الرابعة، الخامسة والسادسة) تمت تغذيتها على غذاء يحتوي على وجبة زهرة الشمس بمستويات 25، 50، 75 و100%.

مجموعات الكتاكيت التجريبية الأخرى (السابعة،الثامنة، التاسعة والعاشرة) تمت تغذيتها بنفس غذاء المجموعات (الثالثة، الرابعة، الخامسة والسادسة) مع إضافة الإنزيم (1جم/كج الفايتيز التجاري). إستمرت التجربة لمدة ستة أسابيع. المعاملات التي تم قياسها (وزن الجسم، استهلاك الغذاء، وزن الجسم المكتسب، نسبة تحويل الغذاء)، خصائص اللحم، مكونات مصل الدم، نشاطات إنزيم المصل والنواحي الإقتصادية.

أوضحت النتائج أن كتاكيت اللحم التي تغذت على كل مستويات امباز زهرة الشمس مع أو بدون إنزيم أدت إلى تحسين آداء الكتاكيت بصورة معنوية على الرغم من ظهور عدم المعنوية بين المجموعات نفسها التي تغذت على مستويات مختلفة من امباز زهرة الشمس.

المستويات المختلفة لامباز زهرة الشمس مع أو بدون إنزيم لم تؤثر معنوياً على مكونات اللحم ما عدا القانصة والقطع التجارية وقيمة اللحم.

إضافة امباز زهرة الشمس مع أو بدون إنزيم في عليقه كتاكيت اللحم سجلت فوائد إقتصادية.

أظهرت النتائج أن امباز زهرة الشمس يمكن أن تكون بديلاً لمصادر البروتين النباتي دون أي أثر سالب.

CHAPTER ONE

INTRODUCTION

Success of poultry industry depends on good management, good hygiene and economic sufficient feed. Poultry industry in the Sudan now is facing great problems, mainly the feed, which represents about 75% or more of the total cost of production, due to the competition between human and animal, scarce in crop production and human population growth (Mukhtar and Abd-Rahim, 2012). Protein and energy are the most costly components in poultry diets, especially the plant protein (Mukhtar, 2007).

Sunflower seed meal (SFM) is considered as a good source of vegetable protein and vegetable oil. However, in recent years there is an increase in the interest of commercial cultivation production in the Sudan.

However, high fiber content of sunflower seed meal increased viscosity of gut contents, poor digestibility and poor chicks' performance (Rad and Keshavarz, 1976; Furlan *et al.*, 2001). The testa of SFM is rich in non-starch polysaccharides (NSPs) which reduce the digestibility of the SFM (Annison, 1993). These negative effects can be overcome by supplementation of diets with suitable exogenous enzymes (Gracia,et.al. 2003; and Mukhatr, 2012; Mariam *et al*., 2013; Mukhatr and Abd-Rahim, 2012 and Munasser, 2011).

Commercial xylam 500 is assumed to degrade high fibre content of NSP resulting in increased nutrient availability to poultry chicks (Khan *et al*., 2006; Binbarik, 2010; Munasser, 2011 and Mariam, *et.al* 2013).

Therefore, objectives of this study were to investigate the nutritional value of SFM as protein source with and without enzyme supplementation on the performance, carcass characteristics, blood constituents, serum metabolites, enzyme activities and economic feasibility of broiler chicks.

CHAPTER TWO

LITERATURE REVIEW

2.1. Description of sunflower

Sunflower plant is a tall, erect herbaceous annul plant belonging to the family of Asteraceae of the genus, Helianthus. Its botanical name is *Helianthus annuus*. The plant possesses a large inflorescence, and its name is derived from the flower's shape and image, which is often used to capture the sun. The sunflower is an erect, coarse and tap-rooted with rough hairy stem 2-10 ft tall. Towards the apex of the plant, there may be a few side stems. The central stem is light green to reddish green and covered with stiff spreading hairs. The leaves are mostly alternate, egg-shaped to triangular and entire or toothed, although some of the small upper leaves may have smooth margins and a lanceolate shape (Pleczar, 1993) .

The inflorescence heads are 7.5-15 cm wide and at the end of branches, it consist of numerous central disk florets’ that yellow to brown, they are surrounded by approximately 20-40 ray floret.

2.2. Distribution

The sunflower is a common and wide spread road side-weed. It’s common in open sites in many different habitats throughout North America, South Africa, China and Colombia (Molina ,1975).

2.3. Production

Sunflower is the important oil seed crop of the world and it ranks third in the production next to groundnut and soybean. The world production of sunflower seeds increased from 31to36 million metric tons between 2004 and 2006 (FAO, 2007).

Sunflower meal is available wide- world population was 13.5 million tons in 2012-2011 (Oil World, 2011). The European Union (EU-27) is main producer and importer; it produced 3.3 million tons and used 5.7 million tons in 2009-2010. Other main producers and exporters were Ukraine 2.5 million tons, Russia 2.3 million tons and Argentina 1.21 million tons, Turkey, Israel and Egypt are main importers after EU (FAS, 2011).

In the Sudan, sunflower grain output increased sharply by 71.4% to reach twelve thousand tons in 2004/05 season compared with seven thousand tons in the previous season (Central Bank of Sudan, 2005).

Sunflower is new edible oil crop in Sudan; many production constraints are responsible for fluctuation in its production and productivity. In Sudan, oil seed crops rank second after cereals in area and total production. The country's oil seed production rests mainly in Sesame, groundnut and cottonseed, while sunflower has been introduced recently into the cropping sequence. The production was established mainly in rain fed areas of the country and to a lesser extent in irrigated conditions.

2.4 Nutritional attributes

Sunflower seeds are rich sources of protein, minerals such as calcium and phosphorus (Salunkhe *et al*., 1991).

Satich and. Shrivastava (2011) re ported that proximate analysis of sunflower air-dried seeds (g/100 g) as 4.12 moisture, 2.996 crude fibers, 33.92 total lipids 24.9 CP, 30.1 total carbohydrates, 4.5 reducing sugar and 25.6 non-reducing sugar. minerals and ash content 4.84, water insoluble ash 1.75, water soluble ash 3.5, calcium 0.12, phosphorus 0.4 and energy 527.03 Kcal.

Fatty acid composition of seeds oil (g/100g) as palmit 2.44-16.0, oleic 18.1-10.72, Linoleic 13.78-18.2, Linolenic 0.24-18.3, amino acids of seed oil as methionine 0.254-0.443, lysine 0.57-0.861, tryptophan 0.22-0.33, cysteine 0.147-0.476 and Arginine 1.586-2.194.

Proximate analysis of decorticated sunflower seeds in Gezira state (Sudan) was reported by Syda *et al*., (2011) as 93.8% DM, 30.71% CP, 13.2% EE, 13.0% CF, 20.75% NFE, 7.14 Ash and 2622 Kcal/Kg ME, while Mahmoud *et al*., (1993) reported 30.62% CP and 11.52% EE.

However, Mahamed *et al*., (2013) found that chemical composition of decorticated sunflower meal as 41.6% CP, 14.7% EE, 8.9% CF, 7.1% crude Ash, 0.96% methionine, 0.45% cysteine and 1.75% lysine.

Variations in chemical composition of sunflower meal might be attributed to location, micro and macro environmental factors or to the different processing methods, which determine the composition of this ingredient used as feedstuff.

Fagbenro et.al, (2010) recorded the chemical compostion of raw sunflower seed meal as (g/100g) 9.48 moisture, 40.01 CP, 20.28 EE, 12.8 CF, 5.89 potassium, 12.19 calcium, 14.58 sodium, 17.17 Magnesium, 0.02 Manganese, 0.03 Iron and 0.01 Copper.

Batal and Dale, (2010), reported that nutrient content of sunflower seed meal of solvent and expeller extract as 93% DM, 1760 and 2310 ME Kcal/kg, 42 and 41% CP, 1.5 and 1.6% methionine, 0.7 and 1.8% cysteine, 1.7 and 2.0% lysine. 0.5 Vs 0.65% tryptophan, 2.3 Vs 7.6 crude fat, 21 Vs 21% CF, 7.0 Vs 6.8% Ash, 0.4 Vs 0.43 Carcass and 1.0% Total phosphorus respectively.

Sunflower is rich in linoleic acid (Senkoylu and Dale, 1999). As well as naturally occurring antioxidants (Rebole *et al*., 2006). Sunflower meal is considered to be lysine-deficient in several monogastric species (Villamide *et al*., 1998 and Menab, 2002). Sunflower meal is also available source of calcium, phosphorus and B Vitamins (Grompone, 2005). The nutrient content of sunflower seeds depends on the variety and growing conditions, which in turn affect the nutrient content of the sunflower seed meal produced after oil extraction. The method of oil extraction also affects the nutrient content of sunflower seed meal. Solvent extraction is a more effective method of oil extraction than mechanical extraction, yet it is important to note that solvent-extracted sunflower seed meal cannot be used in organic poultry diets (United States Department of Agriculture [USDA], 2000). The screw-press extraction method results in a high-oil sunflower seed meal (San Juan and Villamide, 2001).

soybean meal ,respectively, were reported by Lautner and Zenisek(1964) . Grau and Almquist (1945) have reported that sunflower meal is a rich of several B-complex vitamins. Clandinin and Robblee(1950)have concluded that excessive processing temperature decreased the protein quality of sunflower meal. Sunflower seed meal is lower in lysine than soybean meal, but higher in methionine (Senkoylu and Dale, 1999). Processing time and temperature of the sunflower seeds affects lysine available in the final meal. High temperatures during oil extraction can damage the protein. The result is a reduction in the availability of amino acids, especially lysine (Senkoylu and Dale, 1999).

The fiber level of the product depends on the extent to which the seeds are removed prior to oil extraction. High levels of hulls improve oil extraction efficiency but also increase the fiber content of the meal, reducing its potential as a feed ingredient in poultry diets. The variability in percent hulls remaining in the meal is the reason that there is a high variability in poultry performance between sources of sunflower seed meal.

Types of sunflower:

There are two types of sunflowers (Senkoylu and Dale, 1999). One type is high in oil content (40-51%) and is the one most used in production of sunflower oil. Sunflower meal is deficient in lysine in broiler diets. Silveira *et al*. (1967) and Rad *et.al* (1976) demonstrated that the addition of lysine improves the performance of broilers fed diets containing sunflower meal as main protein source.

With high-oleic sunflower varieties, an inclusion of 10% sunflower seed meal can be used to increase the oleic acid (a monounsaturated fatty acid) of chicken meat with no adverse effects on broiler performance (Rebolé *et al*., 2006).

The seeds of these high-oil sunflower are black with a thin hull stuck tightly to the kernel that is difficult to remove. The other type of sunflower has much less oil content (about 25%) and is used primarily in the snack, confectionery, bakery, and bird food markets. The seeds of these sunflowers are larger with a thick, striped hull that is not held as tightly to the kernel. It is much easier to remove the hull from the low-oil varieties

2.5. Anti-nutritional factors

Anti-nutritional factors are those substances generated in natural feedstuffs by the normal metabolism of species and by different mechanisms, which exerts effect contrary to optimum nutrition (Akande and Doma, 2010). These substances found in most foods, they are poisonous, and they are protecting them-selves from being eaten. Since anti-nutrient occurring in small quantities that they cause no harm (Farzana, 2005).

Anti-nutritional factors are mainly organic compounds, which when present in a diet may affect the health of the animal or interfere with normal feed utilization, and they occur as natural constituents of plant and animal feeds, as artificial factors added during processing or as contaminant of the ecosystem (Barnes and Amega, 1984).

Anti-nutritional factors in feedstuffs are classified according to their chemical nature and their activity in animals as chemical natures; in this category are acids, enzymes, nitrogenous compounds, saponsins, tannins, glucosinlates and phenolic compounds. Factors interfering with the digestion, utilization and availability of minerals of dietary protein and carbohydrates for example, tannins, trypsin or protease inhibiters, saponsins and haemagglutinins, phytate, oxalate, glucosinolates and gossypol (Nityanand, 1997).

The anti-nutritional factors in new varieties of sunflower seed are cyanide (4.10/mg CN/100mg), tannin 0.637g/160g, oxalate 0.106g/100g and haemagglutinin 1:58 (Satish and Shrivastva, 2011), Fegbenro and Adaperasi, (2010) found the anti-nutrient composition of raw sunflower seed meal as trypsin inhibitor 0.34 mg/g, 0.23% lectin, 2.85 mg/100g tannin, 13.15 mg/100g phytin, 4.11% saponin and 16.141 mg/100g oxalate. Sunflower is rich in linoleic acid (Senkoylu and Dale, 1999) as well as naturally occurring antioxidants (Rebolé *et al*., 2006). High oleic acid sunflower seeds have higher oleic acid at the expense of linoleic acid (Rebolé *et al*., 2006). The level of the antioxidants in high oleic sunflower seed is similar to conventional varieties.

Having in mind that effect as well as the fact that protein is often one of the most expensive components of poultry diets, nutritionists have started a search for alternative ingredients which have potential as cost-effective protein sources, sometimes underutilized in poultry production (Mushtaq *et al*., 2006). It is well known that sunflower oil is considered one of the most healthful vegetable oils for humans, thus the availability of sunflower meal (SFM), as a by-product, is relatively high (Vieira *et al*., 1992; Stodolak *et al*., 2009). SFM obtained from processed intact sunflower seeds is rich in protein but also has a high content of fibre. Moreover, diets formulated with SFM can be deficient in lysine. The latter could be overcome by an appropriate supplementation. But high level of fibre, causing low dietary energy values, may excessively reduce the time of feed passage throughout the digestive system and diminish nutrients utilization (Wenk, 2001). It is well known that NSP to be anti-nutrients that inhibit the digestion and utilisation of dietary nutrients by the animal and therefore reduce animal performance (Choct, 2006). Senkoylu and Dale (1999) stated that SFM cell wall contains NSP such as β-glucans, xylans, arabans, pectins and oligosaccharides which tend to increase the viscosity of the digesta, lower nutrient utilisation, and lead to depressed growth in chicks, The lower However, inclusion of alternative protein sources such as sunflower meal (SFM) and rapeseed meal (RSM) is limited by the presence of indigestible non-starch polysaccharides (NSP); (Knudsen, 1997; Rama Rao *et al*., 2006; Khajali and Slominski, 2012).

Metabolizable energy of sunflower meal and its deficient utilization by non-ruminant animals are directly related to its high fiber content, resulting in worse live performance (Furlan *et al*., 2001). Waldroup *et al*. (1970) concluded that is possible to include up to 20% of sunflower meal in broiler diets with no lysine supplementation, which was later confirmed by(Valdivie *et al* 1982, and Zatari and Sell 1990).

However, Furlan *et al*. (2001) asserted that up to 15% of sunflower meal can be included in broiler feeds with no effect on performance, Grossenergy values of 4820 and 4864 Kcal./kg .and metabolizable energy values o f 190 7and 269 3Kcal./kg .for sunflower meal.

Unlike most other oilseed meals, sunflower seed meal has not been found to have anti-nutritional factors (Senkoylu and Dale, 1999).

However, the effect of dietary fibre on gizzard development was found to depend on fibre source and its particle size (Hetland *et al*., 2005; Amerah *et al*., 2009; Svihus, 2011; Mateos *et al*., 2012).

2.6. Uses

The seeds are used for snacks and for bird food, a preparation of the seeds has been widely used for cold and coughs, treatment of malaria, as a diuretic and expectorant (Heiser, 1976). The roasted seeds have been used as coffee substitute.

Sunflower seeds control cell damage, thus playing a role in preventing cancer, because seeds are a good source of selenium which as proven enemy of cancer. They contain bone-healthy minerals (calcium, magnesium and copper). As a bonus, seeds contain vitamin E, which helps ease arthritic pain. The magnesium in sunflower seeds is reputed for soothing the nerves, this easing a way stress, migrains and helping you relax. They ease every condition that is inflammatory in nature, such as joint pain, gastric ulcers, skin eruptions, asthma, because sunflower seeds are leaded with anti-oxidants (Heiser, 1976).

Sunflower stalks have been used as fuel, fodder for livestock, food for poultry and ensilage (Heiser, 1976), hulls could be used for litter for poultry or returned to the soil composed, also hulls are used in manufacturing ethyl alcohol and furfural, in lining play wood and in growing yeast.

Leaves of sunflower can be used as cattle feed, while the stems contain a fiber which may be used in paper production. Sunflowers can be processed into bean nut butter alternative, sunflower butter. In Germany, it is mixed with rye flour to make bread.

The sunflower oil, extracted from the seed, is used for cooking, as carrier oil and to produce margarine and biodiesel, as it is cheaper than olive oil. The seedcake used as a livestock feed. Some varieties grown as ornamental plants (Heiser, 1976).

Merman, (1986) found that the sunflower leaves used to treat kidneys, for chest pains and pulmonary troubles (Glimore, 1977), oil from the seeds was used to lubricate or paint the face and body, seeds used as stimulant the appetite, a decoction of sunflower rooted protected sucking children and to alleviated rheumatism. Women who become pregnant while still nursing a child take a sunflower seed medicine to prevent sickness in the child (Kindscher, 1992).

The hulls or shells are mostly composed of cellose. They are burned as biomass fuel (Zabaniotou *et al*., 2008).

2.6.1. Sunflower meal as ruminant feed

Sunflower meal has been used to feed ruminant for a long time and was already praised in the 19th century as an excellent ingredient (Cornevin, 1982). Numerous experiments have since confirmed that even in its non-dehulled form, sunflower meal is used without problems in ruminant diets as protein supplement.

Sunflower meal is suitable as the sole source of supplemental protein in diets for dairy cows (Blair, 2011). Milk production was similar when partially dehulled (Schingoethe *et al*., 1977) or fully dehulled sunflower meal (Parks, et.al1981), replaced soybean meal in dairy cow diets (Blair, 2011). In the US, sunflower meal has been widely used in beef cow supplementation programs (Anderson, 2002).

Brunschwig *et al*., (2002) replaced rapeseed meal in high yielding dairy cows up to 15% and found no effect on milk yield and composition. Addition of sunflower meal to maize bran, 4kg/day crossbred zebu cows in Tanzania by Mlay *et al*., (2005) increases milk yield (8.1 Vs 6.61 L/day), and no effect on milk consumption. Jabbar *et al*., (2008) found no effect on milk yield and milk fat but lower weight gain when they replaced cottonseed meal concentrate by 18-40% SFM in lactating crossbred cows rations.

Sunflower meal can be used as the sole source of protein in beef rations and in commonly SFM with other protein source, equal animal performance in commonly observed based on iso-niterogenous diets from different source (Richardson *et al*., 1981 and Anderson, 2002).

Numerous trials have been tested successfully the inclusion of SFM in fattening lamp diets as a substitute for soybean meal, cotton seed meal or groundnut meal. SFM was also found to promote better wool growth than cotton seed meal due to its higher content in sulphur amino acids (Richardson *et al*., 1981; Suliman *et al*., 2007; Santos-Silva *et al*., 2003).

SFM can replace other protein sources in the diets of dairy ewes. Expeller sunflower cake (6% oil) tends to increases milk concentration of the isomer and of unsaturated fatty acids (Amores *et al*., 2010; Dutta *et al*., 2002; and Mandaluniz *et al*., 2010).

2.6.2 Use of sunflower meal in poultry diets

Sunflower oil meal by-products obtained after the extraction oil from decorticated sunflower seeds. being a good source of vegetable protein (40% CP), the sunflower meal can be developed as a good vegetable protein supplement for different poultry.

In poultry feeding, sunflower meal is considered as a protein rich but lysine-deficient and high fiber ingredient, whose fiber fraction is mainly composed of insoluble sugars, resulting in low ME values that depend on the actual fiber content (Villamide *et al*., 1998). It may be cost effective to use sunflower meal for poultry diets in countries where soybean meal is not available or too expensive (Senkoylu *et al*., 1999).

Dehulled sunflower meal have higher ME values than non-dehulled meals, as they contain more protein and less fiber. Mechanical-extracted sunflower meal has a higher ME value due to its higher oil content, but it’s less valuable as a protein source due to its lower protein. Process may have complex effects, positive and negative, on the nutritional value of sunflower meal (San Juan *et al*., 2001). Diets containing large amount of sunflower meal including high oil meal, tend to be bulky, resulting in lower feed consumption. Reducing bulkiness by pelleting increases feed intake and subsequently performance (Senkoylu *et al*., 2006).

The use of sunflower meal in animal feeding has been limited due to the high fiber content caused by residual seed hulls. The meal quality in terms of digestibility for poultry and monogasteric as well as protein content، is very variable (Coombs and Hall, 1999 and Keshavarz, 1976).

Silva, (1990) reported that sunflower meal can be used in diets in complement with other lysine-rich feed sources, but the high level of fiber in SFM contributes to a reduction in the energy digestibility of the diets.

Cortamira *et al*., (2000) found that SFM in substitution of soybean meal requires the addition of vegetable oil and lysine in diet.

In rabbit feeding, SFM is a dual purposes raw material, being both a source of balanced protein and a source of lignin-rich fiber. It is an ingredient suitable for rabbit feeding without technical restriction provided that protein level, protein quality and fiber composition are taken in account in diet formation. SFM supplies only about 70% of the lysine requirement for growing and breeding rabbits, but exceeds the requirements for sulfur amino acids, theronine and tryptophan (Lebas, 2004).

Sunflower seed meal can be included in poultry diets at the maximum recommended level depending on the quality of the specific product being used. This will vary by variety of sunflower grown and the method of oil extraction. Compared with solvent extraction, the heat and mechanical pressure that occurs with mechanical pressure extraction reduces amino acid availability (San Juan and Villamide, 2001).

2.6.3. Use of SFM in laying hens

As a consequence, SFM is a more suitable ingredient for laying hens than for birds with higher protein and energy requirement, such as broilers and turkeys (Cetion, 2003). It is a possible to introduce up to 30% of SFM, in layer diets without affecting performance (Deaton *et al*., 1979). In other birds species, pelleting may also improve feeding efficiency by decreasing the bulkiness of SFM based diets, for instance in water fowl diets (Vetesi *et al*., 1998).

In turkey diets, the inclusion rate of SFM seems to be more limited (less than 14%), as turkey have higher requirements for protein and amino acids because sunflower meal may induce undesirable effects (Juskiewicz *et al*., 2010).

Syda *et al*., (2011) studied the substitution of groundnut meal by diet. They concluded that SFM can be use as alternative protein source ingredient up to 26% in layer diets and can replace 100% groundnut meal without hazard effects. Substitution of 50% groundnut meal or inclusion of 13% SFM in layer diets resulted in the best performance of layers in term of feed intake, body weight gain, egg number, egg mass, feed conversion ratio, laying and highest profit.

Karunajeeura *et al*., (1999); Vieira *et al*., (1992); Senkoylu and Dale,(1999); Casartelli *et al*., (2006) and Talha and Yaguob, (2008) reported that SFM can substitute groundnut meal in layers ration without altering the laying hens performance, also could completely substitute soybean meal.

Elzubeir and Musharaf, (1991), revealed that SFM can be used in layers ration and that layers will benefit more from SFM inclusion in their diets

Fofiolu *et al*., (2013) fed laying hens on diets containing undecorticated SFM with or without exogenous enzyme supplementation. Results of the early lay period showed significant reduced in feed intake and final weight values as the level of undecorticated SFM increased in the diet and feed intake and egg produced per hen day.

2.6.4. Use of SFM in broilers:

When feeding broiler breeder pullets, feed restriction is often used to prevent the pullets from becoming obese. The use of high fiber diets has been shown to be equally as effective without the need for strict feed restriction (Zacek *et al*., 2003). Sunflower seed meal can be The high fiber content of sunflower meal also limits its use in poultry diets. According to Taverneri *et al*. (200 8), the use of exogenous enzymes may be a solution for this problem, as these hydrolyze the non-starch polysaccharides, which then could be used by the birds, increasing, for instance, energy utilization

Research work done on broilers (Ibrahim and Elzubeir, 1991; Musharaf, 1991; Senkoylu and Dale, 1999; Tevernari *et al*., 2008; Rao *et al*., 2009 and Talha and Yagoup, 2008), studied the effect of replacing groundnut cake with decorticated sunflower cake on broiler chicks performance, they found that decorticated sunflower cake can replace up to 100% of groundnut in broiler chicks starter and finisher diets.

Mandal *et al*., (2003), reported that inclusion of undecorticated SFM of 0.0, 5.0 and 10% level replacing part of soybean meal in broiler chicks' diet had no significant effect in body weight gain and feed intake during starter or finisher period. Replacement of groundnut cake in the diet of growing chickens by sunflower cake improved growth rate an efficiency of utilization of energy and protein (Singh and Parasad, 1979).

Pinheiro *et al*., (2002) found better economic performance when broilers were fed 4% SFM from 36-42 day of age. Lucio *et al*., (2011) studied the effect of SFM inclusion in diets formulated on total or digestible amino acids basis fed to broilers of 22 to 42 days of age. They found that inclusion of 15% of SFM worsen feed conversion ratio and the use of SFM does not influence the carcass and cuts yield. Also Rama Rao *et al*., (2006) verified that SFM can replace up to two thirds of soybean meal in broiler diets.

Broiler fed diets containing 35% SFM performed better than those fed a diet containing canola meal (Kocher *et al*., 2000), similar results were found with a 20% inclusion of SFM in low-energy broiler diets (Aftab, 2009). Waldroup *et al*., (1970) recorded possible inclusion of SFM up to 20% with no lysine supplementation, which was later confirmed by(Valdivie *et al*., 1982 and Zatari and Sell, 1990). However, Furlan *et al*., (2001) asserted that up to 15% of SFM can be included in broiler feed with no effect on performance, with lysine supplemented.

Nassiri *et al*., (2012) concluded that increasing levels of SFM in the diet quadraticaly effect (in grower and finisher phases), but body weight gain (in starter and grower phase) were linearly affected. Therefore sunflower meal can be used in broiler diets at levels up to 140g/kg and its fiber content has no significant effect on nutrient intake.

Adeniji *et al*., (2007) studied the replacement value of high fiber hulled sunflower seed cake(HSFSC) for soybean cake in broiler diets at 0, 25, 50 and 70% levels. The study suggested that not more than 50% HSFSC (22% crude fibers) could be replaced with soybean cake protein in the diet of broiler chicken without adverse effect.

Kamal and Khalid, (2013) conducted studay to evaluate the effect of undecorticated sunflower seed meal on the performance of broiler. Result indicated that incorporation of sunflower seed meal had no significant (P>0.5) effects on feed intake, live weight gain, feed conversion ratio, mortality, hot and chilled percentages.It was concluded that addition of sunflower up to 15% to replace groundnut had no harm or undesired effects.

Adejuno and William (2006) reported that sunflower meal can replace groundnut cake and soybean meal(SBM) up to 75% level without negative effect on performance and production in broiler chicken diets.

Rehman *et al*., (2002) studied the effect of substitution of soybean meal with canola meal(CM) and sunflower meal on the performance of broilers, the results showed that the weight and dressing percentage were comparatively improved ($P<0.05$) where SFM was used as source of protein.

However, CM and SFM could successfully replace 50% of SFM. The 100% substitution of SBM with SFM resulted in high feed consumption with poor weight gain, feed conversion ratio, carcass weight, dressing percentage and liver enlargement which could be attributed to comparative poor nutritional value and nycotoxin susceptibility of SFM. Conversely, high fiber sunflower seed meal was included in broiler diets up to 30% with no adverse effects on growth or feed efficiency (Ibrahim *et al*., 1991). Inclusion of high fiber sunflower meal, however, adversely affected layer performance when included in the diet at greater than 8.9% (Vieira, 1992). soybean meal (Aziz *et al*., 2001), corn gluten meal (Babidis *et al*., 2002) or yeast as a single-cell protein source (Daghir and Abdoul-Baki, 1977).

2.6.5. Effect of feeding sunflower cake

Oliveira *et al*. (2007) evaluated two sunflower meal inclusion levels (0 and 15%), with or without an enzyme complex (cellulase, protease, and amylase) in the diet of 21 to 42-day-old broilers, and did not find any significant interactions between sunflower meal and the enzyme complex. Those authors concluded that the dietary inclusion of 15% sunflower meal improves live performance, but does not affect carcass yield. Mccinnis *et al*. (1948)and Klain *et al*.(1956)have presented data indicating that the nutritive value of sunflower meal couldbe improved by the addition of DL lysine emonohydrochloride Research suggests that high oil sunflower seed meal can be included up to 28-30% in broiler diets with no adverse effects on growth or feed efficiency. Pelleting can improve performance (Senkoylu and Dale, 2006).

The use of sunflower meal (SFM) in poultry diets is limited by variations in chemical composition, and the two main components apparently restricting its usage are the high fiber/ low energy and low lysine contents (Senkoylu and Dale, 1999). Working on layers Michael and Sunde (1985) reported that sunflower meal is relatively rich in sulphur amino acids but is deficient in two limiting amino acids, lysine and threonine. Furlan *et al*. (2001) found that soybean meal could be replaced by sunflower up to a level of 30% in diets with equal energy and amino acid (digestible methionine + cysteine and lysine) ratios

2.7 Enzyme supplementation to SFM-Based diets

Some exogenous enzymes may be added to broiler diets containing SFM to aid fiber digestion (carbohydrases) or to solubilize phytic sunflower seed (SFS) contains more ether extract (EE) (38%-40%)and is available at a relatively price. This high EE content contributes to a high ME per unit or high energy density of feed. The increased production and availability of hybrid SFS coupled with its oil content makes SFS a potentially desirable ingredient in poultry feeds.

Monogastric animals like poultry, pig's etc. lack the alloenzymes from rumen microflora and thus it become necessary to incorporate the enzymes in their diets in order to derive optimal nutrient utilization from complex feed matrix. Feed enzymes are added to animal feed to increase the availability of nutrient by digesting the feed component during storage or after consumption within the gastrointestinal tract, some of the enzymes that have been used over the past several years and have potential for use in feed industry include cellulose (B-gluconase), xylanase and associated enzymes, phytase, proteases and galactosidases . Most of the enzymes used in the feed industry have been applied for poultry to neutralize the effect of viscous, non-starch polysaccharides in cereals such as burley, wheat, rye and triticale.

The application of industrially produced enzymes, amylase and protease, to enhance starch and protein utilization in animal nutrition date back to the late 1950's or early 1960's (Burnett, 1962).

A resume of exogenous enzyme used in poultry diets. Biologically, enzymes are protein, catalyzing all metabolic processes in animal, plants and microorganisms. Every enzyme has its own unique properties, like specific activity, substrate affinity, stability, pH and temperature sensitivity, and can be classified by the substrate upon which it reach.

The testa of SFS and cereal grains is rich in non-starch polysaccharides (NSPs) which reduce the digestibility of the SFM/cereal grains. These NSPs are polymeric carbohydrates which differ in composition and structure from starch (Annison, 1992) and possess chemical cross linking among them and therefore, are not well digested by poultry (Annison, 1993). A part of these NSP is water soluble which notorious for forming age like viscous consistency in the intestinal tract (Petterson, 1987). Predominantly water soluble and viscous arabino xylans (belong to pentason group) are assumed to be the factor responsible for the low metabolizable energy (ME) in cereal grains (Choct and Annison, 1990), resulting in relatively per chick performance (Friesen *et al*., 1992).

These pentasons, which were the main constituents of the endosperm cell wall of cereal grains, greatly increase the water intake by the bird which leads to unmanageable little problems caused by wet and sticky dropping (Dunn, 1996). Similarly ß-glucanase also adversely affects all nutrients, especially protein and starch utilization is known to give rise to highly viscous conditions in the small intestine of the chicks (Hesselman and Aman, 1986).

Research suggest these negative effects of NSP can overcome by supplementation of diets with suitable exogenous enzyme preparations (Zanella *et al*.,1999; Gracia *et al*., 2003), as those hydrolyze the non-starch polysaccharides, which then could be used by the birds, increasing for instance, energy utilization (Taverneri, *et al*., 2008).

Oliveira *et al*., (2007) evaluated two SFM inclusion levels (0.0 and 15%) with or without enzyme complex (cellulose, protease and amylase) in the diet of 21-42 day old broilers and did not find any significant interactions between SFM and the enzyme complex.

Srinivason and Jeichitra, (2012), investigated the effect of feeding different levels of SF cake and enzyme supplementation on egg quality traits of breeder quails. Results showed that the egg trails were neither influenced by feeding different levels of SFC nor by enzyme supplementation.

Alam *et al*., (2003) studied the effect of exogenous enzyme in diet on broiler performance. They found that the growth rate, feed intake, feed conversion ratio, dressing yield and profitability were increased by addition of exogenous enzymes.

Mushtaq *et al*., (2009) conducted an experiment to study the influence of SFM based diets supplemented with exogenous enzyme and digestible lysine on performance, digestibility and carcass response of enzyme addition in low nutrient density and high SFM diets (300g/kg).

Moreover, digestible lysine is not suggested to be lowered than 10g during 1-21 day and it may be reduced to 9gm/kg if a single diet having high level of SFM in planned to be offered during 1-42 day.

Khan *et al*., (2006), studied the influence of exogenous enzymes supplementation to sunflower-corn based diet on digestive and performance traits in broilers. Results showed that birds fed the enzyme supplemented diets consumed more grow faster and had better feed conversion than those fed the control diet (phytase), thereby reducing their negatives effects on broiler production parameters. Reports on the results of the inclusion of sunflower meal in broiler feeds are controversial According to(Furlan *et al*. 2001).

The commercial microbial phytase 1000 (composed of 800 U/gm, amylase and 1620 U/gm 1-4 β-phytase) obtained from khayrat ELNile, Khartoum, Sudan.

CHAPTER THREE

MATERIALS AND METHODS

3.1 Duration

The experiment was conducted in Poultry Farm, College of Agricultural Studies, Sudan University of Science and Technology, during the period 15/2/2015-21/3/2015 through which the ambient temperature ranged between 27^{o}c to 32^{o}c

3.2 Housing

The house is semi closed system, east-west long axis , the house dimensions were length and width and height(24*8*3) .Thirty seprate replicates of equal size $1m^2$ per each were formulated from wire net partitions, were used each replicates were provided with wood shaving litter , feeder and drinker to allow free consumption of feed and water which were supplied ad libitum, heat lamps were used for the control of heating and lighting and had put in away to ensure adequate and uniform distribution of heat and light, light was on during the period of whole night ,to protect the chicks from cold.

Strict sanitation program was maintained in the house before and during the period of experiment.

3.3 Experimental birds

Two hundred and ten unsexed commercial broiler chicks (Arbor acers) were selected after a week of adaptation period .Chicks were fed pre-starter diet through adaptation period .

Chicks were distributed randomly to ten experimental diets (A,B,C,D,E and A+, B+, C+, D+, and E+) in a complete randomize design , each treatment had three replicates of 7 birds per each.

Chicks were vaccinated against infectious bronchitis disease (IBD) and Newcastle disease at age of 7 days and 29 days respectively Gumboro disease at age of 14 days and 20 days, Chicks in all groups have been given water soluble multivitamin compounds during the three days before and after each vaccination to avoid the stress.

3.4 Experimental diets

Each treatment was be divided into three replicates with 7 chicks per replicate. Each diet was prepared in two variants, with and without non-starch polysaccharide (NSP)-degrading enzymes. The chicks on group A will be served as a negateve control diet without enzyme , groups B, C ,D and E fed diets with SFM without (enzyme) at levels (25, 50, 75, and 100% SFM) respectively, Diet A+ used as positive control diets, B+, C+, D+ and E+ were similar to diets B,C,D and E but they were supplemented with 1000g/ton commercial phytase enzyme.

Table 1. Composition of the experimental diets used % .

Feed	Control	25%	50%	75%	100%
Sorghum Grain	64.0	64.0	64.0	63.25	63.0
Ground nut cake	14.0	12.0	8.8	7.5	0.0
Sesame cake	15.0	9.55	5.5	0.0	0.0
Sunflower cake	0.0	7.25	14.5	21.75	29.0
Concentrate**	5.0	5.0	5.0	5.0	5.0
Oyster shell	0.487	0.8	0.95	0.95	1.2
D.C.P*	0.5	0.5	0.5	0.5	0.5
Lysine	0.343	0	0	0	0
Methionine	0.1	0.3	0.3	0.4	0.44
v.oil	0	0.34	0.15	0	0.85
Vitamin***	0.2	0.2	0.2	0.2	0.2
Salt	0.25	0.25	0.25	0.25	0.25
Total	100	100	100	100	100

*D.C.P=dicalcuim phosphate

** Concentrate = Broiler concentrate: Crude protein 40%, crude fat 3%, crude fiber 1-5% Lysine 13-5%, Methionine 5-9%. Methionine + cystic 60.25%, calcium 6.8% Phosphorus

*** Vitamin and Minerals supplemented per kg: at. A 300.000 IV, at D3 100.000IV, at E 4.00ppm, at K 98ppm, at B2 1.320ppm, at B12 400ppm, pantothenate 2.0ppm, Niacin 20.0ppm, Folic acid 100ppm, copper 15.0ppm, iodine 250ppm, selenium 50ppm, Manganese 24.0pp, Zinc 20.0ppm, Iran

Table 2. Calculated composition of experimental diets

	Control	**SFE25%**	**SFE50%**	**SFE75%**	**SFE100%**
ME	3100.33	3108.91	3103.82	3101.60	3101.96
CP%	22.8	22.66	22.14	22.53	22.28
DM	88.03	87.73	87.89	87.61	87.08
CF	4.18	4.9	5.65	6.4	5.47
Ash	4.75	4.32	4.00	3.61	3.43
NFE	53.67	54.19	54.73	55.0	55.01
Ca	1.1	1.1	1.1	1.14	1.0
Phosphorous	0.65	0.613	0.6	0.60	0.66
EE	4.62	4.86	5.22	5.44	5.00
Lysine	1.3	1.25	1.25	1.31	1.33
Methionine	0.61	0.61	0.55	0.53	0.56

Table 3. Chemical compostion of sunflower meal cake

Fat %	Protein%	Ash	Moisture
19.37	27.76	6.17	6.05

3.4 Parameters

Body weight and feed intake were recorded weekly, and body weight gain and feed conversion ratio (FCR) were also calculated weekly and mortality was recorded daily.

3.5 Carcass preparation

At the end of experiment, 6 weeks, three birds that their body weights were close to group average from each treatment, were selected, after they were weighted individually. Blood samples were collected from two birds per ground in heprinized test tubes, centrifuged and stored for analysis. Selected birds were slaughtered, scaled in hot water after bleeding, feather plucked manually then washed and eviscerated. Hot carcass, heart, head, gizzard, abdominal fat and liver were weighted, carcasses were chilled at 4 C^o for 24 hours, then weighted (cold weight), then were sawed into two halves. The left side then divided into the commercial cuts (breast, thigh, and drumstick). Each cut was weighted individually then deboned to determine the weight of meat and bone of each cut. The meat was frozen for chemical analysis and panel test.

3.6 Panel taste

The stored right side of carcass of each bird was slightly seasoned, wrapped in aluminum foil and roasted at 190 C^0 for 70 minutes with average internal temperature of 88 C^o and served warm. Ten semi-trained taste panels were used to score color, flavor, tenderness and juiciness of meat (Cross *et al*., 1978) at scale of 1-8 (Appendix1) the samples were served randomly to each judge and at room temperature. Water was provided for the panelists to rinse their mouth after tasting each sample.

3.7 Chemical analysis

Stored meat samples were cut into small pieces twice and duplicate samples were analyzed for crude protein, fat, ash and moisture content as described by the AOAC (2000). Diets were analyzed for DM by oven during method, ash by muffle furnace, CP by Kjeldahl method, EE by Soxhlet fat analysis. Nitrogen free extract (NFE) and metabolizable energy (ME) were calculated by (Ellis,1981) formula.

3.8 Calculation

The hot and cold carcasses weights were expressed as apercentage of live weight carcasses. non-carcass components (heart, liver, gizzard and legs)were expressed as a percentage of hot carcasses weight. commerical cats(breast, drumstick and thigh)were expressed% of cold carcasses meat and bone weight of commercial cats were expressed as% of their cuts weight

3.9 Statistical analysis

Complete randomize design was used for the study. The collected data were subjected to statistical analysis using analysis of variance technique. Multiple means comparisons were made using LSD Multiple Test (Steel and Torrie, 1982).

3.10 Blood sample

Blood was collected from by vein of wing, plasma was separated and analyized for total protein, cholesterol, phosphors, calcium, SGOT and SGPT using kits.

CHAPTER FOUR

RESULTS

The effect feeding different levels of sunflower seed meal (SFM) with or without enzyme on the performance broiler chicks showed in (table4).Results obtained showed that chicks fed on positive diet (control with enzyme) recorded significantly ($P<0.05$) heavier body weight compared to group negative control. Also data obtained revealed an increase in body weight with the increase in (SFM) level in the diet but without any significant ($P>0.05$)

However, there is an increase in the body weight with the enzyme supplementation in the diets compared to those without enzyme.

Chicks fed on positive control consumed significantly ($P<0.05$)more feed compared to chicks on negative control .All treated groups with and without enzyme except chicks fed on 25%SFM with and without enzyme consumed significantly ($P<0.05$) more feed compared to both negative control and 25%SFM in feed intake.

Broiler chicks fed on positive control recoded significantly ($P<0.05$) heavy body weight gain campared to group fed on negative control show in (table 4). –chicks fed on all levels of SFM with or without enzyme recorded significantly ($P<0.05$) heavier weight gain compared to the negative control group, without any significant ($P>0.05$)difference between them ,so without any interaction recorded due to enzyme or SFM level.

Chicks fed on positive control diets showed significantly ($P<0.05$)the best FCR compared to all treated groups, followed bygroup fed on 50% with enzyme .there is no significant difference ($P>0.05$)among groups fed on different level of SFM with or without enzyme and negative control groups in FCR .therefore, results revealed no interaction between different levels of

SFM and enzyme supplementation on the performance of experimental chicks.

The inclusion of different levels of SFM in broiler diet with or without enzyme (table7) did not significant affect (P>0.05) on breast , thigh and drumstick weights and their meat and bone weight, Although there are alinear decreas increase of SFM levels in diets. The effects of feeding broiler chicks on different levels of SFM with and without enzyme supplementation on non carcass components are illustrated in(table 7).

Data obtained for heart, liver, leg,neck, and head for chicks fed on diets with or without enzyme showed no significant (P>0.05)difference effect (table 8).

However there is a significant increase in gizzard weights with the inclusion of SFM without enzyme supplementation .

The indusion SFM up to100% with or without enzyme in broiler diets recorded ahigh prolitabilty ratio compared to group fed on negative control ,however, group fed on 50%SFM with enzyme recorded the highest profitability ratio(table10)

Table 4. Performance of broiler chicks fed on different levels of SFM with or without enzyme

Treatment	Enzyme	Final body weight	Feed intake	Weight gain	FCR
Control	With	2447.1^{A}	4013.5^{AB}	2222.9^{A}	1.8056^{c}
	Without	2070.5^{c}	3869.7^{C}	1873.1 ^{C}	2.0994 ^{B}
Sunflower25%	With	2164.8^{B}	3904.8^{C}	1937.4^{BC}	2.0158 ^{BC}
	Without	2141.0^{B}	3904.8^{C}	1910.7 ^{BC}	2.0414 ^{BC}
Sunflower50%	With	2407.1^{B}	4125.9^{A}	2182.4$^{A B}$	1.8907 ^{BC}
	Without	2221.0^{B}	4020.9^{AB}	2002.6 ^{B}	2.0074 ^{BC}
Sunflower75%	With	2252.9 ^{B}	4166.7^{A}	2018.3 ^{B}	2.0647 ^{B}
	Without	2255.2 ^{BC}	3994.0^{AB}	2029.8 ^{B}	1.9675 ^{BC}
Sunflower100%	With	2007. ^{E}	4053.4^{AB}	1784.0 ^{B}	2.2765 ^{A}
	Without	2182.4^{CD}	4156.5^{A}	1954.5 $^{B C}$	2.1285^{B}
SE±		103.88	76.154	80.023	0.0804

SE±:standard error of the means.

Means on the same raw with the same superscripts are not significantly different(P>0.05)

Table 5. Performance of broiler chicks fed on different levels of SFM with or without enzyme

Factor(A)	Final body weight	Feed intake	Weight gain	FCR
With	2255.9^{A}	4052.9^{A}	2029.0^{A}	2.0107^{A}
Without	2174.0^{B}	3992.9^{A}	1954.1^{A}	2.0488^{A}
SE±	34.057	46.458	35.787	0.0360

Table 6. Performance of broiler chicks fed on different levels of SFM

Factor(B)	Final body weight	Feed intake	Weight gain	FCR
Sunflower0%	2258.8^{AB}	3968.6^{AB}	2048.0^{A}	1.9525^{B}
Sunflower25%	2152.9^{BC}	3887.3^{B}	1924.0^{BC}	2.0285^{B}
Sunflower50%	2314.0^{A}	4073.4^{A}	$2092.^{A}$	1.9490^{B}
Sunflower75%	2254.0^{AB}	4080.3^{A}	2024.0^{AB}	2.0161^{B}
Sunflower100%	2095.0^{C}	4105.0^{A}	$1869.^{C}$	2.2025^{A}
SE±	53.849	73.457	56.58	0.0568

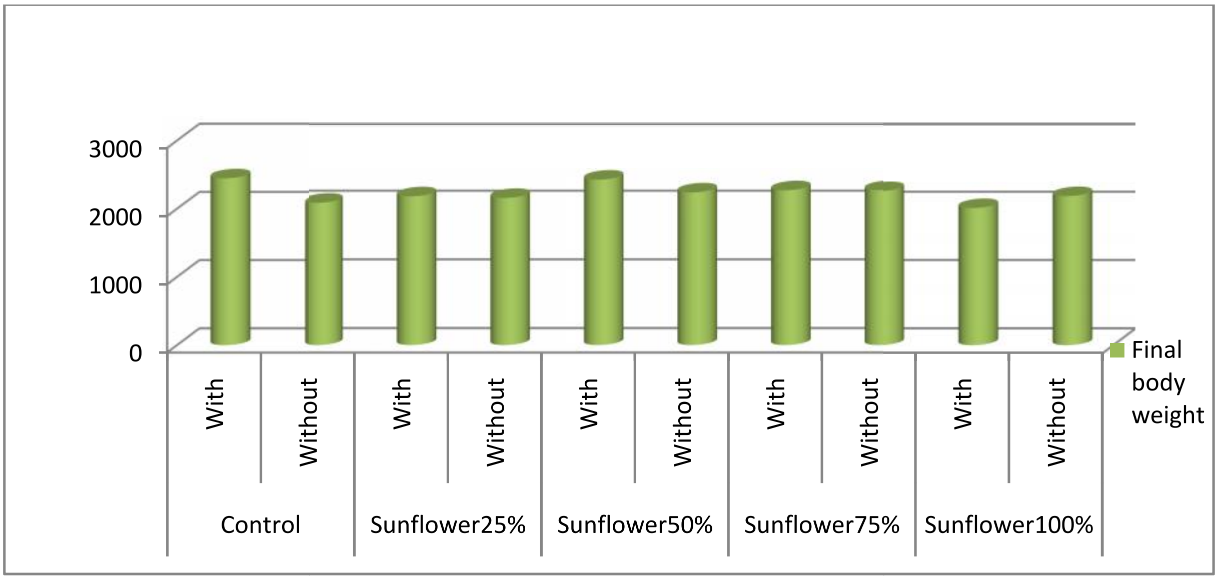

Fig. 1. Final body weight

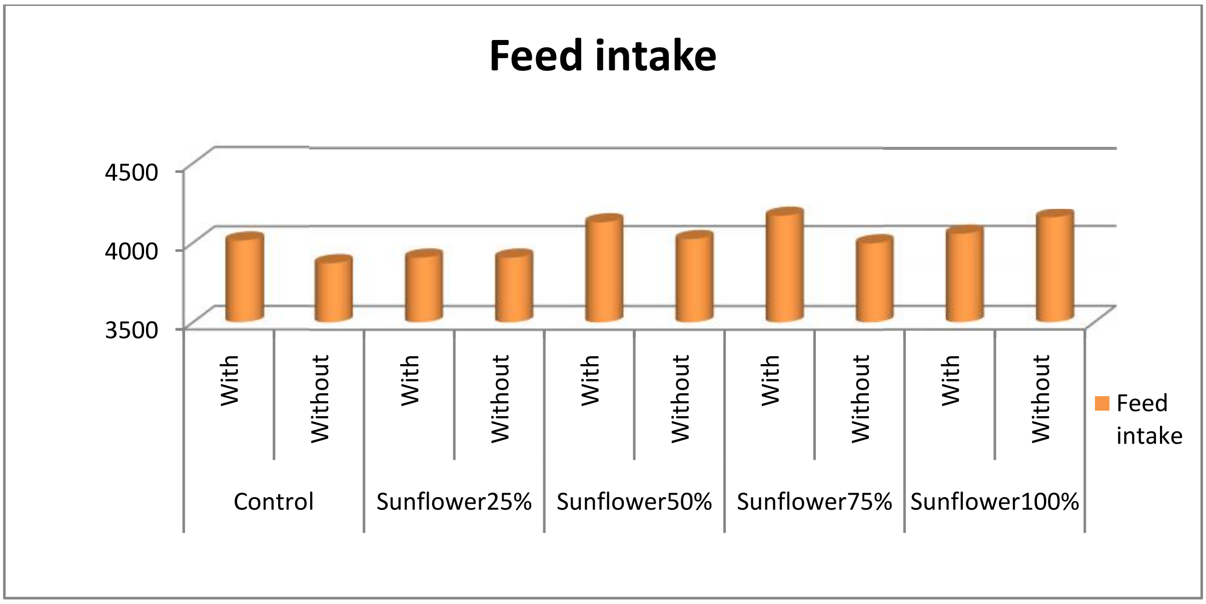

Fig. 2. Feed intake

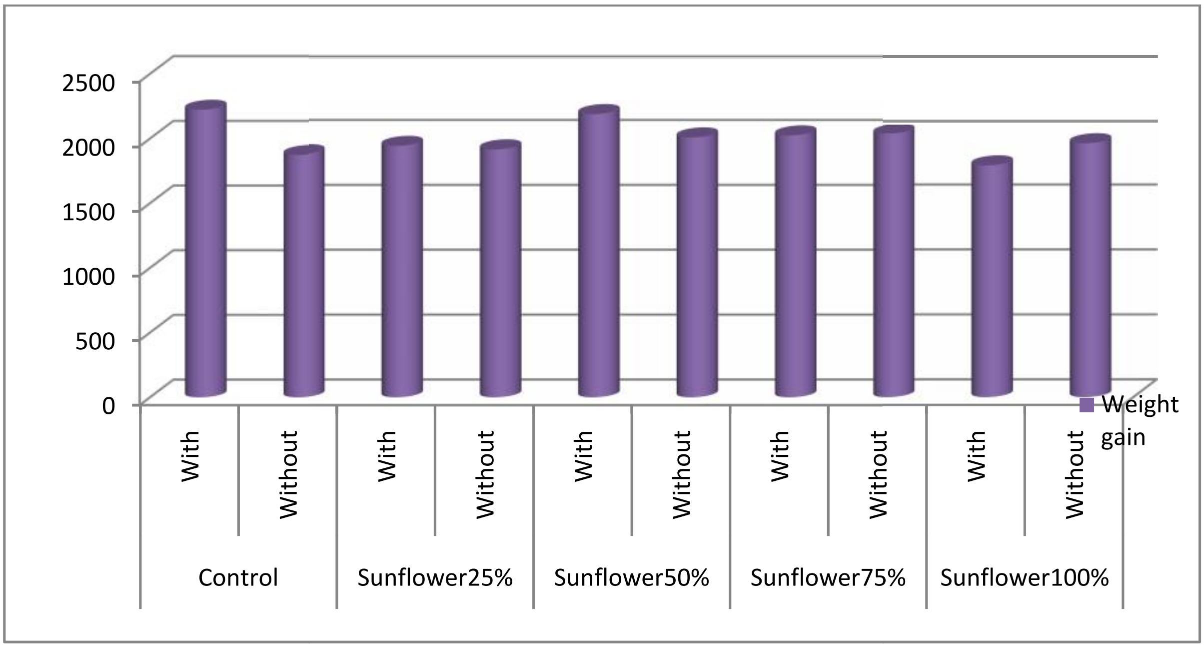

Fig. 3. Weight gain

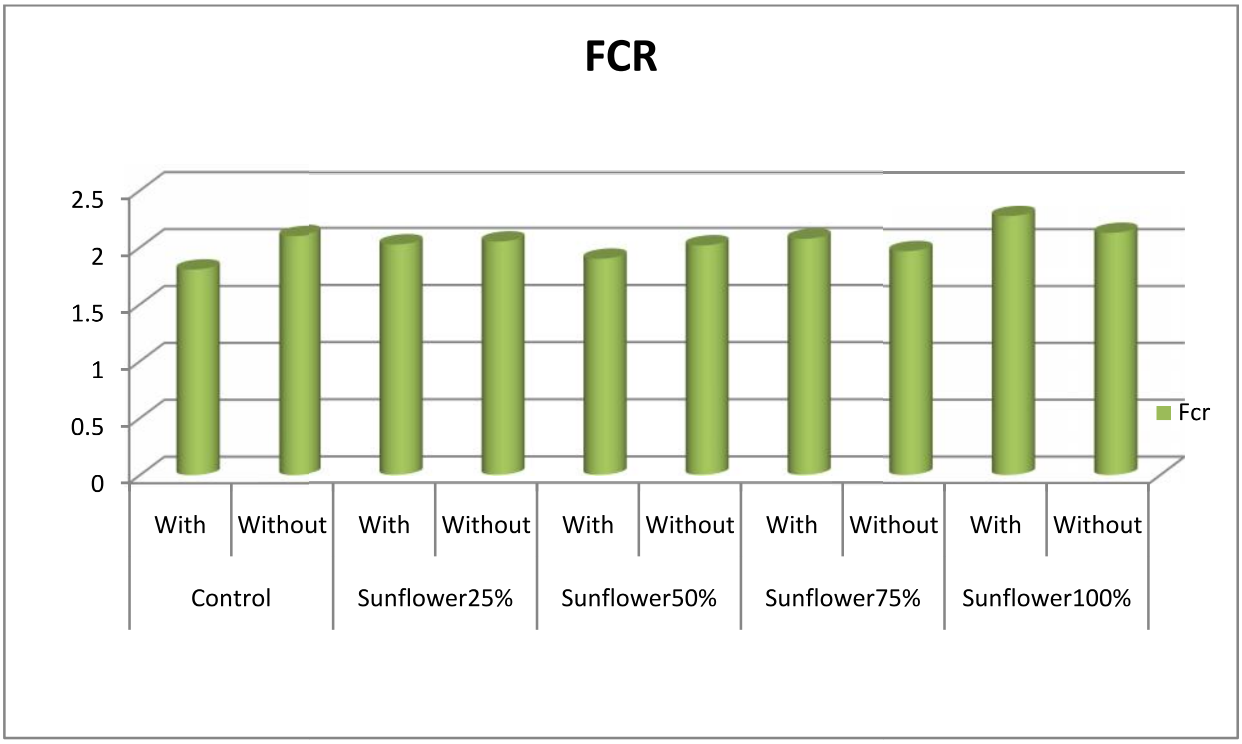
FCR
2.5
2
1.5
1
0.5
0
Fcr
With
Without
With
Without
With
Without
With
Without
With
Without
Control
Sunflower25%
Sunflower50%
Sunflower75%
Sunflower100%

Fig. 4. Fcr

Table 7. Effect of experiment treatment on percent of commercial cuts from final body weight:

Treatment	Enzyme	Breast	Bone breast	Meat breast	Thigh	Meat thigh	Bone thigh	Drumstick	Meat drumstick	Bone drumstick
Control	With	21.609^{A}	8.114^{A}	91.886^{A}	9.0725^{A}	86.149^{A}	13.851^{B}	7.2222^{A}	73.789^{A}	26.211^{B}
	Without	20.596^{A}	9.198^{A}	90.802^{A}	9.1442^{A}	86.713^{A}	13.287^{B}	6.7282^{A}	79.258^{A}	25.742^{B}
Sunflower25%	With	18.426^{AB}	9.094^{A}	90.906^{A}	8.9398^{A}	87.285^{A}	13.715 ^{B}	7.1714^{A}	73.590^{A}	25.410^{B}
	Without	17.278^{C}	9.460^{A}	90.540^{A}	8.2595^{A}	86.372^{A}	13.628 ^{B}	6.4357^{A}	73.877^{A}	24.123^{B}
Sunflower50%	With	18.702^{AB}	8.805^{A}	91.195^{A}	8.8733^{A}	87.339^{A}	13.140 ^{B}	7.0160^{A}	74.752^{A}	25.248^{B}
	Without	18.279^{BC}	8.447^{A}	92.553^{A}	8.8374^{A}	87.879^{A}	13.053^{B}	6.8089^{A}	73.983^{A}	21.017^{B}
Sunflower75%	With	18.636^{A}	8.095^{A}	91.905^{A}	8.8310^{A}	86.860^{A}	13.053^{B}	8.1901^{A}	73.057^{A}	26.943^{B}
	Without	18.355^{BC}	8.806^{A}	91.194^{A}	8.8067^{A}	81.947^{A}	13.895^{B}	6.9312^{A}	74.294^{A}	25.706^{B}
Sunflower100%	With	20.084^{B}	8.354^{A}	91.646^{A}	8.1448^{A}	88.559^{A}	13.801^{B}	6.8470^{A}	75.550^{A}	24.450^{B}
	Without	20.138^{B}	8.827^{A}	91.173^{A}	8.3212^{A}	86.199^{A}	13.7357^{B}	75.380^{A}	74.620^{A}	24.620^{B}

Means: without subscripts showed no significant difference(P>0.05)

Table 8. The effect of experimental diets on non component carcass:

Treatment	Enzyme	Heart	Liver	Leg	Neck	Head	Gizzard
Control	With	0.5746^{AB}	2.0303^{AB}	3.491^{B}	4.1722^{B}	2.3419^{A}	2.4858^{B}
	Without	0.4623^{AB}	1.8684^{AB}	3.339^{B}	4.587^{B}	2.2754^{A}	2.6415^{A}
Sunflower25%	With	0.4683^{AB}	1.8055^{AB}	3.640^{B}	3.9432^{B}	2.2751^{A}	2.0679^{BC}
	Without	0.5519^{AB}	1.9992^{AB}	3.723^{B}	4.991^{B}	2.1507^{A}	2.6905^{A}
Sunflower50%	With	0.4824^{AB}	1.9575^{AB}	3.904^{B}	4.294^{B}	2.1517^{A}	2.1892^{BC}
	Without	0.5171^{AB}	2.0574^{AB}	12.609^{B}	4.0579^{B}	2.936^{A}	2.3647^{ABC}
Sunflower75%	With	0.4755^{AB}	2.0585^{AB}	3.242^{B}	4.2919^{B}	2.3420^{A}	2.5170 B
	Without	0.5735^{AB}	2.0971^{AB}	4.202^{B}	3.9262^{B}	2.4042^{A}	2.5515^{AB}
Sunflower100%	With	0.4602^{AB}	1.8431^{AB}	2.825^{B}	3.9901^{B}	2.1463^{A}	2.0002 C
	Without	0.5108^{AB}	1.9421^{AB}	3.545^{B}	4.958^{B}	2.2047^{A}	2.5736^{AB}

Table 9. Panal taste

The average subjective meat quality scores (tenderness, color, flavor, and juiciness) were not affected significantly by inclusion of SFM with or without enzyme supplementation among the tested groups as shown in table (8)

Treatment	Enzyme	Tenderness	Flavor	Color	Juiciness
control	With	6.8	6.8	6.6	7
	without	6.5	6.4	6.4	6.6
Sunflower25%	With	7	6.9	6.6	6.9
	without	6.6	6.4	6.5	6.8
Sunflower50%	With	6.7	6.7	6.7	6.9
	without	6.6	6.7	6.6	6.8
Sunflower75%	With	6.6	6.7	6.7	7
	without	7	6.8	6.5	6.8
Sunflower100%	With	6.5	6.7	6.6	6.6
	Without	6.6	6.6	6.5	6.5

Table 10. Economical study of adding SFM with or without enzyme supplement:

Treatment	Enzyme	Total cost	Total revenue	Profit	Profitability ratio
Control	With	25	66.069	41.069	1.308
	Without	24.5	55.89	31.39	1.0
Sun flower25%	With	24	58.428	34.428	1.097
	Without	23.2	57.780	34.58	1.101
Sun flower50%	With	23.5	64.989	41.489	1.322
	Without	23	59.967	36.967	1.178
Sunflower75%	With	23.5	60.804	37.304	1.188
	Without	22.4	60.885	38.485	1.23
Sunflower100%	With	22.4	54.189	31.789	1.013
	Without	23	58.914	35.914	1.144

Table 11. Serum constituents:

Also the results showed that addition of SFM with or without enzyme supplement has no significant difference in blood constituents

Treatment	Enzyme	SGOT U/L	SGPT U/L	PO4 mg/dl	Ca mg/dl	T.P g/dl	Cholostrol
Control	With	55.15	16.9	3.05	7.9	6.85	107
	without	58.3	16.35	2.9	8.2	7.77	109
Sun flower25%	With	53.95	16.35	3.05	8.1	6.1	103
	without	54.64	17.45	2.85	8.8	7	105.5
Sun flower50%	With	55.6	19.2	3.25	8.03	6.95	107
	without	59.14	19.98	3.05	9.1	7.5	107
Sunflower75%	With	59.14	19.98	3.05	8.3	6.3	111
	without	56.5	18.77	3.05	8	6.5	110
Sunflower100%	with	54.5	19	3.05	8.2	7	105
	without	54.7	19	3.05	8.4	7	106

CHAPTER FIVE

DISCUSSION

The apparent health of experimental chicks was good throughout the experimental period and in all treatments. SFM had no effect on mortality rate. This might be also to the good salinity, also environmental temperature feel within thermo neutral zone during the experimental period.

The collected data concerning the performance of broiler chicks fed on diets containing different levels of SFM with and without enzyme revealed an improvement in body weight of experimental chicks with the increase of SFM levels in the diet but without any significant compared to the negative control (without enzyme and SFM). These results were in line with the findings of Mandal *et al*., (2003). They found that inclusion under corticated SFM replacing part of soybean fed in broiler chicks' diets had no significant effect in body weight gain and feed intake during starter or finished period. Also Singh and Parasad (1979) found that replacing of groundnut cake in the diet of growing chickens by SFS improved growth rate. These might be due to that sunflower seeds are rich source of protein, minerals (Salunkhe *et al*., 1991, Grompne, 2005), rich in linoleic acid (Senkoylu and Dale, 1999) as well as naturally occurring antioxidants Robole *et al*., (2006) and rich in several B-complex vitamins (Grau and Almquist, 1945).

Results obtained revealed that all treated groups fed on diets containing SFMwith or without enzyme except those fed on 25% SFM with and without enzyme consumed significantly ($P<0.05$) more feed compared to negative control group.

The body weight gain of the experimental chicks fed on different dietary SFM with or without enzyme showed significantly heavier weight gain compared to the negative control group and without any significant difference among them.

These results were in agree with the findings of Ibrahim and Elzubeir, (1991), Musharaf (1991), Senkoylu and Dule (1999), Tavernar *et al*., (2008), Rao *et al*., (2009) and Talha and Yagoub (2008) whom recorded that decorticated sunflower cake can replace up to 100% of groundnut in broiler starter and finisher diet without any effect in body weight gain and feed intake. Also results were in line with that of Kamal and Khalid (2013) who found that incorporation of SFM in broiler diets had no significant effect on feed intake, live weight gain, feed conversion ratio, mortality, hot and chilled percentages. It might be attribute to comparative poor nutritional value and nycotoxin susceptibility of SFM.

Results obtained revealed that all treated groups with and without enzyme except chicks fed on 25% SFM consumed significantly ($p<0.05$) more feed compared to the negative control group. This might be due to low energy and low lysine content of SFM (Michael and Sunde, 1985). The high level of fibre of SFM cause low dietary energy value that may excessively reduce the time the feed passage throughout the digestive system and diminish nutrients utilization (Wenk, 2001, Knudsen, 1997, Rama Rao *et al*., 2006; Khajali and Slominskr, 2012) and therefore reduce animal performance (Choct, 2006).

Chicks fed on positive control diet showed significantly ($P<0.05$) the best FCR (1.8056) compared to all tested groups, followed by group fed on 50% SFM with enzyme (1.8907), however, there is significant difference among groups fed on different levels of SFM with or without dietary enzyme compared to negative control group.

This might be to high consumption of feed by chicks to compensate the low dietary energy values, so that non- starch saccharide of SFM posses chemical cross linking among them and therefore, are not well digested by poultry (Annison, 1993).

The supplementation of experimental diets containing different levels of SFM with exogenous enzyme improved the performance of experimental chicks, this might be due to that exogenous enzyme hydrolyze the non- starch polyssacharides which could be used by birds increasing for instance energy utilization or to solubilize phytic sunflower seed. These results were in line with result reported by Alam *et al*., (2003). They found that the growth rate, feed intake, feed conversion ratio, dressing yield and profitability were increased by addition of exogenous enzymes. Also Khan *et al*., (2006) recorded that more feed consumption, faster growth and better FCR to chicks fed sunflower- corn based diet supplemented with exogenous enzymes compared to those fed on control diet.

The inclusion of different SFM levels with or without enzyme in broiler diet, did not significantly affect on the commercial cuts (breast, thigh, drumstick) and their meat values, although there are numerical decrease with the increase of SFM levels in diets.

Results also revealed no significant effect on non- carcass components (heart, liver, neck). These results were inline with the founding of Lucio *et al*., (2011) who found that inclusion of SFC in broiler diet did not influence the carcass and cuts yield. However, there is an increase with the SFC level increase in the diet without exogenous enzyme in gizzard weights. This might be due to high feed consumption level which excessively reduce the time the feed passage throughout the digestive system. The result was agreed with that of (Hetland *et al*., 2005; Amerah *et al*., 2009; Svihus, 2011and Mateos *et al*., 2012).

The data obtained from this experiment revealed that there is no interaction between different levels of SFM and dietary enzyme supplementation on the performance of experimental chicks. The result was agreed with the findings of Oliveira *et al*., (2007) who evaluated two SFM inclusion levels (0 and 15%) with or without an enzyme complex (cellulosa, protease and amylase) in the diet of broiler chicks and did not find any significant interaction between SFM and enzyme complex.

The result of economical evaluation of different levels of SFM with or without dietary enzyme showed that the inclusion of different levels of SFM resulted in economical benefits compared to negative control group, however, the group fed on 50% SFM with enzyme recorded the highest profitability ratio (1.322). The same result was reported by Pinheiro *et al*., (2002) who found better economic performance when broilers fed 4% SFM from 36- 42 day of age.

CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion:

- All levels of SFM with or without dietary enzyme improved the performance of broiler chicks.
- Inclusion of different levels of SFM with or without dietary enzyme did not effect significantly non- caracass yield and commercial cuts values.
- Supplementation of SFM diets with dietary enzyme improved chicks performance compared to negative group.
- Inclusion of different SFM with or without dietary enzyme was economically feasible.

6.2 Recommendations:

1. According to the results of this study, SFM could be considered a good source of vegetable protein and can be included in broiler diets up to 100% with enzyme supplementation.
2. Further experiments are needed to determine the SFM effect on meat quality and its effect on blood serum.
3. Study the effect of SFM on the performance and production of layer.
4. Study the effect of different SFM supplemented with combination of enzymes.

CHAPTER SIX

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Appendices

Appendix(1)

Temperature during experimental period

Week	Maximum	Minimum	Average
Week1	32	29	30.5
Week2	28.6	27.3	27.95
Week3	31.6	25	28.3
Week4	32	28	30
Week5	35	32	33.5

Humidity

	Maximum	Minimum	Average
Week1	37	35.3	36
Week2	48	32	40
Week3	39	30	34.5
Week4	45	34	39.5
Week5	45	40	42.5

Appendix (2)

Card used for judgment of subjective Meat quality attributes

Sensory Evaluation Card

Evaluate these sample for color , flavor, juiciness and tenderness. For each sample use the appropriate to show your attribute by checking at the point that desk describes your feeling about the sample , If you have any question please ask. Thanks for your cooperation.

Name________________________________Date_________________________________.

Tenderness	Flavor	Color	Juiciness
8-Extremely tender	8-Extremely intense	8-Extremely desirable	8-Extremely Juicy
7-Very tender	7-Very intense	7-Very desirable	7-Very Juicy
6-Moderately tender	6-Moderately intense	6-Moderatel desirable	6-Moderately Juicy
5-Slightly tender	5-Slightly intense	5-Slightly desirable	5-Slightly Juicy
4-Slightly tough	4-Slightly bland	4-Slightly desirable	4-Slightly Juicy
3- Moderately tough	3- Moderately bland	3- Moderately undesirable	3- Moderately dry
2- Very tough	2- Very bland	2- Very undesirable	2- Very dry
1- Extremely tough	1- Extremely bland	1-Extremelyundesirable	1- Extremely dry

Serial	Sample Code	Tenderness	Flavor	Color	Juiciness	Comment